REPORT

of the

AIR FORCE

SPACE STUDY COMMITTEE

(Unclassified)

20 March 1961

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I. INTRODUCTION

The Air Force Space Study Committee was established 11 October 1960 by Lt. General B. A. Schriever under the chairmanship of Mr. Trevor Gardner to review current ARDC space development objectives and resources and to recommend a program which would enable the Air Force to effectively meet its development responsibilities in space in the 1960 - 1970 time period.

As the work of the Committee progressed it became apparent that examination of this complex subject required strong technical and management assistance. Accordingly, the Los Alamos Study Group was established and met for nine weeks as a full-time technical evaluation and support group. In addition, selected Committee members participated in the discussions of a special Management Group whose report is incorporated as Section VII. Detailed information concerning these groups and their activities is appended.

The Committee did not address itself to the general or specific budgetary and facilities aspects of the military space problem. Further, the Committee did not give direct consideration to space research and development undertaken by the U. S. Army or U. S. Navy.

II. THE SOVIET SPACE THREAT

The military implications of the frequency and payload size of Soviet space launches are a major cause of alarm for all members of our Committee.

The USSR has placed 12 devices in orbit with a total announced payload of 78,000 pounds. Since 19 August 1960, the USSR has placed four major satellites in orbit, and one major space probe:

1. SPUTNIK 5 -- 10,120 pounds payload
2. SPUTNIK 6 -- 10,037 pounds payload
3. SPUTNIK 7 -- 14,292 pounds payload
4. SPUTNIK 8 -- 1,410 pounds VENUS Probe from estimated 14,100 pounds in orbit.
5. SPUTNIK 9 -- 10,362 pounds payload

SPUTNIK 5 landed at a time and place of Soviet choosing. SPUTNIK 6 and SPUTNIK 7 burned up in the atmosphere. SPUTNIK 8 spacecraft is enroute to Venus. Each of these devices could have contained military intelligence and communication equipment or possibly a nuclear warhead. SPUTNIK 9, which carried a dog and other forms of life, also was recovered at a time and place of their choosing.

Current opinion is that this SPUTNIK series is aimed at successfully launching a man into space and the development of spacecraft. Other probable objectives are preparation for a rendezvous in space and manned lunar exploration. Each of these goals, when achieved, will have serious military as well as national prestige implications.

III. INTERNATIONAL IMPLICATIONS

Each launch into space is an event of international interest, significance, and concern. Each announced plan to conduct an experiment in space, or even to study a space system, is similarly a subject of international attention. Facilities to support space operations are already distributed around the globe, and more will be added.

Because of the U.S. - USSR asymmetry in accessible intelligence, satellite reconnaissance systems are of fundamental importance to our national security. Similarly, since we do not contemplate striking first, early warning systems such as MIDAS are necessary to alert our forces. Our policy of nuclear deterrence dictates that we place a high priority upon the effective functioning of communications satellites to permit effective command and control of our forces.

The USSR, however, argues that these systems are being developed to facilitate surprise or pre-emptive strikes against them. Currently, this argument has led to verbal attacks, political harassment, and attempts to sway world public opinion against their use.

Our insistence on classifying space activities as either "military" or "peaceful" has exposed us to unnecessary international political problems. This classification provides the Soviets with a convenient focus for attack upon our most vital space programs. The USSR does not attempt this distinction and so can proclaim its activities as entirely "peaceful". This is probably a distortion, and is unsupported by concrete evidence. There are many valid reasons to believe that the USSR has a need for military space systems.

IV. MOTIVATIONS FOR AN INCREASED SPACE EFFORT

A. National Security

Reconnaissance, surveillance, communications, meteorological, and navigation satellites will contribute vitally to our military strength. We must develop capabilities to protect them and the capability to neutralize unfriendly satellites.

New military possibilities in space will arise, and may produce major shifts in the balance of military power.

National security considerations alone justify a major increase in the Department of Defense space effort.

B. Other Motivations

Achievements in space have provided a new international index of a nation's position in world leadership. Our allies, the uncommitted nations, and the emerging new nations watch this index. The USSR clearly recognizes this fact.

Using a vigorous program of space activities as a dramatic backdrop, the USSR seeks to demonstrate to the world that their political and economic system is superior to ours; that their military capability is superior to ours; that their methods of energizing and utilizing the capabilities of their people are superior to ours; that their society responds to new challenges more vigorously and more surely than ours; that the power and vitality of the Communist state is superior to ours, and that these divergences will increase.

The total reaction of our society to the challenge and opportunity of space in the three and one-half years since SPUTNIK I have been a repetitious story of too little, too late. We have achieved some scientific and military progress but not enough to prevent great damage to our image of world leadership.

Unless we meet the Soviet challenge with a dramatically invigorated space program, our international prestige will be further damaged.

While security is of primary importance to the general welfare, other benefits also result from a vigorous national space effort. Meteorological, navigation, and public communication satellites are already in the development or planning stage. As space technology advances, the nation must be prepared to support these uses of space and the resulting technical developments, utilizing the skills and resources of private industry.

The new knowledge acquired from the exploration and utilization of space will have profound effects on virtually all branches of science. Observations of biological phenomena in environments which cannot be produced on earth, perhaps including the discovery of new forms of life, direct observations of planets forming parts of other solar systems, measurements of the characteristics of magnetic fields and charge particles in interplanetary space, and the determination of the composition of various parts of the lunar and planetary surfaces, are but a few of the striking examples of this new knowledge resulting from direct observation.

The exploration and utilization of space will require a greatly expanded technology. The evolution of this new technology will lead to further developments in other fields which have no direct connection with the space effort. Some of these include the creation of new materials, power sources, and electronic devices. The emergence of new services through direct and indirect application of space technology will not only satisfy presently apparent needs and wants, but will tend to generate new wants for which no demand yet exists.

V. EXISTING LEGISLATION AND POLICY

In July 1958, the Congress enacted the National Aeronautics and Space Act. This Act states that it is the policy of the United States that activities in space should be devoted to peaceful purposes for the benefit of all mankind and assigns primary responsibility to NASA. It recognizes the security aspects of space by exception and assigns this responsibility to the Department of Defense. This division was implemented without recognizing and understanding the central importance of basic capabilities (such as large boosters) to both programs. Since launch vehicles already developed for military purposes were available, the unsoundness of this approach was not immediately evident.

The launch vehicles used in our space programs to date were developed by the Department of Defense with the speed and urgency characteristic of important military programs. Reliability was achieved through the extensive testing required to provide operationally useful devices.

Future launch vehicles will have both military and civil uses. The urgency of military need cannot await the slow, eventual attainment of

reliability. Development of reliable basic capabilities by an organization experienced in urgent developments and operations will better support the military space program as well as the civil and scientific space program.

A clear basis for the development of basic capabilities by the Department of Defense and access by NASA to those capabilities needed in specific scientific experiments must be defined. The precedent for military support of great enterprises of exploration is well established (e.g. Navy and Air Force support of Antarctic exploration). While the role that the Air Force is to play in the U. S. exploration of space is not yet determined, both past experience and existing resources indicate that this role should be a major one, and should be established in the near future.

The preamble of the Space Act states that "space is for peace". The inhibitions against military participation in space efforts and the full exploitation of the military potential have been so strong that both the space program and national security have suffered. Something approaching a tacit unilateral arms development moratorium has prevailed in this area.

If space activities are to be separated into the scientific study and exploration of space, and the development and use of space systems in national defense, a third fundamental part also must be recognized. This is the achievement of certain reliable basic capabilities required by both NASA and the Department of Defense. This third area has been almost neglected and is the one in which the U.S. space program is most deficient.

Space technology continues to evolve at an almost explosive rate. Space operations are difficult and expensive. Nevertheless, reliability of a new device or technique can be attained only by repeated launchings. The Committee feels it is important that the development of reliable capabilities be accomplished independently of the scientific study and exploration of space.

The development of basic capabilities must not be paced or confined by either the scientific study of space phenomena or the definition of weapon system requirements.

The recently announced change in Air Force organization is an initial step toward improving the decision making process for space developments. In the last decade we have come to realize that basic research will best support and make feasible the proper decisions if it is funded and managed independent of systems development.

We now require a similar action to fund and manage the development of reliable fundamental space capabilities, independent of, but closely integrated with, systems development. This poses an immediate point of focus for the newly defined Air Force space organization - the Air Force Systems Command.

VI. FORMAL MILITARY REQUIREMENTS

Within the Air Force, a dogma prevails that technical developments, particularly those involving any substantial application of resources, must be justified by a specific weapon system which is in turn tied to a clear military requirement.

Space systems requirements are treated just as if both the framework of strategy and the technical boundary conditions were known. Our knowledge of space technology is still too incomplete to permit a full understanding of future military space systems and operations. Full technical knowledge, basic capabilities, and military strategy required to support such operational requirements are not yet in hand.

The military utilization of space combines a rapid technological change with long development time for fundamental capabilities. New possibilities and needs will continue to arise with little warning. Only advanced development of fundamental capabilities can prepare us for these demands.

The development of urgently needed technical capabilities such as boost, rendezvous, maneuverability and communications are essential to the speedy attainment of effective military use of space. The premature initiation of "systems" produces inefficiencies and may severely limit or foreclose the opportunity for the full development of such fundamental capabilities.

At the present time the Air Force role in space is envisioned too narrowly. Air Force operational resources should be used to advance the national interest by accomplishing scientific investigations and providing logistic support for such activities as space exploration, and orbiting arms control satellites.

VII. KEY ORGANIZATIONAL PROBLEMS

A special group of experts in the fields of management and organization, including selected members of this Committee, was convened to study this problem and prepare a report. A list of members of this management group is appended.

The Management Study Group concludes that:

1. The reorganization of the Air Force Ballistic Missile Division into a Space Development Force, proposed by ARDC[1], is a necessary and urgent organization change.

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1. Presented to the Management Study Group on 15 January 1961 by Lt General B. A. Schriever

2. The proposed Air Force reorganization[2] will greatly contribute to national and Department of Defense management needs in space technology and operations, but this organization will not be fully effective unless there is a better defined organizational structure at the Department of Defense and national level.

3. The magnitude of the space programs to come - military, non-military, or mixed - requires a single focal point for policy direction at the highest level of the Defense Department. The vast experience and resources of the Air Force space organization should have streamlined access to this focal point.

4. The Department of Defense space program is of sufficient urgency that special priorities, management reporting channels, and control should be established similar to those which were put into effect by the Air Force in 1955.

5. The Management Study Group believes that the Air Force (AFBMD) development capabilities must be an essential part of any national booster program.

6. The proposed formulation of a Space Development Force within the Air Force is at best only a belated application of the principle of management by exception. A sharpening of military management of new enterprises, accompanied by a focusing of Department of Defense leadership on the national organization required for space must be pressed so that:

a. Innovation and development can proceed from conception to use without the damaging delays which arise from the lag in time between the phrasing of "requirements" and the aggressive exploitation of new technical opportunities.

b. The pursuit of new technological opportunity can proceed unfettered by the layer upon layer of reviewing, coordinating, and negating functionaries that now exist in the military departments, the Department of Defense, and other organizations within the Executive Branch.

7. As in other military development programs of major importance, the space development program is now caught in the constriction between two different management philosophies within the military service - the older traditional position that operations and procurement should preempt major vigor and resources of the military, and the new reality that national security in an age of science demands that the emphasis and authority of research and development for exploiting technology be primary. The principal Air Force and Department of Defense leaders must move to reflect

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[2] The Air Force has recently announced a reorganization along the general lines of these recommendations.

the modern state of global technological change by relieving this constriction through a shift of attention, emphasis, and authority to the decision making machinery of research and development.

VIII. PERSONNEL ACTIONS

In preparation for both its military use of space and for its part in the exploration of space, the Air Force should accelerate and modify the training of its personnel. Specifically:

1. The Air Force Academy, and other educational resources of recognized academic quality, should be required to educate competent officers for space development and space operations.

2. The Chief of Staff should establish special military career incentives for the Space Development Force based upon educational qualifications and experience which will induce able Air Force flying officers to embrace the rigorous studies and disciplines required to convert them into qualified Space Development officers.

3. Until these actions provide an adequate supply of officers for space development and space operations, the Air Force should establish a major educational resource to undertake the training of qualified Air Force officer personnel in the disciplines required by space technology. This educational effort should embrace at least a special 12 months training program for not less than 1,000 officers per year.

4. The Air University, the Air Training Command and other Air Force service training activities should adjust their programs to reflect the dynamic requirements for trained personnel which are emerging from space developments and operations.

IX. BIOMEDICAL AND CLINICAL RESEARCH

The increasing importance of the biomedical and clinical problems of man in space calls for a reorganization and recasting of the Air Force effort on these problems. Specifically:

1. A central Aerospace Medical Laboratory should be established under the Air Research and Development Command. Clinical research would remain under the direction of The Surgeon General of the Air Force.

2. Extended manned space operations should be a particular concern of such an organization, which must therefore emphasize development of techniques for extended support of life in space, definition of radiation shielding requirements, and other critical problems.

3. The NASA should be invited and encouraged to participate in the activities of the Laboratory.

X. LARGE PAYLOAD CAPABILITIES

Current Launch Vehicle Development Situation

a. The current national booster activity and publicity tend to create the impression that everything possible is being done to accelerate the program. The existing propulsion development program is characterized by a cautious, step-by-step philosophy, rather than by parallel development and concurrent production typical of a truly accelerated program.

b. Ambiguity in space exploration and operation policies as noted earlier in the report has led to government and public confusion about the present speed and scope of the United States booster program. While reasonable progress has been made on the "large" vehicles suitable for future NASA work, the issue of being able to launch large payloads which appear imminently possible in the international competition now has been virtually bypassed. This must be changed at once so that national public understanding of the urgency of multi-ton launchings through DOD facilities is established.

Needs for Large Payloads

1. Presently planned launch vehicles can provide increased national security through improving our reconnaissance capabilities, safer manned orbital and rendezvous experiments, increased communications capability and, a backup to existing satellite programs whose boost capability is marginal.

2. Payloads in the range beyond our near-future capability are the central requirement of the entire space program. Among the military capabilities which will require larger payloads are advanced reconnaissance satellites, manned space stations, and, exploration of space. Manned supervision in space may be required for effective utilization of advanced payloads and may well require even larger payloads.

3. Experience shows that we are almost certain to "under-imagine" the possible uses of space for national security. Space technology continues to develop so rapidly that substantial uses for payloads of all sizes will be conceived only after development of the corresponding launch capability is well along. Presently foreseen uses for these capabilities are manned lunar landing and return, and manned planetary exploration.

4. The development of large boosters for satellites and space exploration will also make possible ICBM's carrying large payloads. The desirability of developing such weapons depends on a number of technical, strategic and political considerations.

Military Uses of Space: 1946-1991

Published by:
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Military Uses of Space: 1946-1991 provides a detailed record of the strategic importance of the U.S. military space program from the conceptualization of the uses of space to the present realization of advanced capabilities. Materials were identified, obtained, assembled, and indexed by the National Security Archive, a non-profit, Washington, D.C. based research institute and library. The microfiche collection is accompanied by Military Uses of Space: 1946-1991 Guide and Index.

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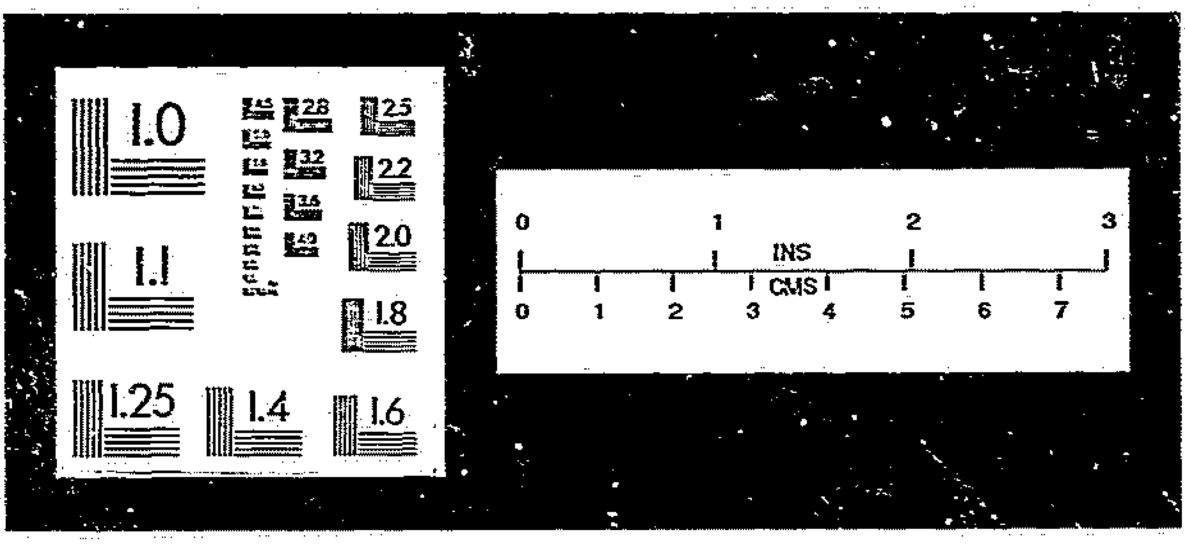

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Extension of Payload Capability by Rendezvous

The possibility of assembling large payloads in space through rendezvous (initially unmanned but later at manned stations), in the opinion of this Committee, should receive emphasis along with the large booster program. The rendezvous approach emphasizes the need for a special standardized class of boosters to achieve low cost per pound in orbit. However, these boosters (which will increase in size with the passage of time) will also be needed for non-rendezvous tasks. In rendezvous, as in non-rendezvous operations, special man-rated boosters will be required which are designed to minimize launching hazards. This emphasis on safety will generally limit manned launch operations to the use of boosters which have the greatest background of reliable experience.

Propulsion Systems -

The use of extensively tested engines is the surest way to attain early reliability of standardized launch vehicles. Military engines already developed for ICBM programs will have been tested far more than an engine of comparable thrust developed for another purpose. Consequently, standardized launch vehicles which use liquid fuels should emphasize the use of military engines, clustered as appropriate.

Large solid fuel rockets offer promise of reliability through simplicity. Low launching costs are likely to make their overall costs competitive. Advantages of solid engines must be sought in factors such as reliability, safety, simple and rapid checkout, storability, adaptability to modular construction, and overall cost.

The F-1 engine provides 1.5 million pounds of thrust in a single thrust chamber, and also promises further growth through clustering. There is an urgent need to accelerate development of the F-1 engine and associated launch vehicles. The parallel development of SATURN C-2 and vehicles using the F-1 engine will not only ensure the earliest possible availability of large boosters but will also permit an experience-based understanding of the comparative merits of clusters of smaller engines vs. a single large engine.

The "hybrid rocket", combining solid and liquid propellants in a single engine, offers some potential advantages for space propulsion in packaging efficiency, higher combined specific impulse and density, and thrust control.

Nuclear propulsion may more than double the specific impulse attainable while still maintaining high thrust to weight ratios and could make possible the utilization and exploration of space on a truly vast scale.

Electrical propulsion systems, though capable of high specific impulses, are limited to very low thrusts. Hence, their use in space will

will be restricted to providing propulsion for slow orbital transfers, interplanetary missions, auxiliary control, and possibly for counteracting orbital drag of satellites in very low altitude orbits.

Thrust to weight limitations are set by the electrical power supplies, rather than by the thrust systems. Auxiliary space power supplies, having high power to weight ratios and long lifetimes, are required for numerous applications and should be actively developed. Most of these developments will be directly applicable to electric propulsion systems.

Placing objects in space is very costly. This high cost has led to a fixation that space systems will become more useful when the cost of boosting is reduced. In turn, this has generated a number of studies on booster recovery and the resulting estimates of the cost of placing payloads in orbit. These suffer from the deficiency that no realistic estimate of the number of launches can now be made and no data exist on the costs of refurbishing boosters which themselves are constantly changing in design.

Analysis of present launching costs indicates clearly that the cost of boosters delivered to the site is not dominant in the cost of present space launchings. Savings due to simplification of prelaunch procedures should receive greater attention than recovery and rescue of booster hardware.

XI. MANNED SPACE CAPABILITIES

The great and difficult explorations of the past and present - Lewis and Clark, the Great Southwest, the Arctic and Antarctica, upper air research and the ocean depths - have all been supported, and in many cases participated in by the military services. During peacetime the services have provided a ready reservoir of trained personnel, leadership and experience in the organization and execution of difficult exploratory missions. The exploration of space cannot, and should not be conducted otherwise.

Today we know how to gather vast quantities of data in orbit. The reception and use on earth of selected portions of these data is of vital importance to national security. The amount of equipment to provide adequate communication links from orbit to earth of capacity sufficient to bring back all information creates a need to filter information in orbit and then transmit only a selected portion to earth. Today there is no efficient substitute for a man as the information filter. Tomorrow it may be reasonable to use radio or optical communication links of greatly increased capacity, or frequent de-orbiting of small capsules, to bring all the information to the earth. However, it is unlikely that information filtering in orbit can be more efficiently performed by machines than by man.

Reliability is the greatest problem for the continuous operation of devices in orbit. The more complex the device the greater its possibility of failure. The presence of a man to make and interpret tests, and to take

corrective action will make possible reliable continuous operation for much more complex systems. While improved reliability of individual elements is a goal of great importance, and one toward which continuing progress is essential, it is unlikely that such improvements will do more than keep pace with the growth in complexity of orbital devices.

As the functions to be performed in orbit become more varied and complex, the need for flexibility in perception and action will increase. Very large capacity communication links to earth combined with very flexible internal and external sensors and effectuators offer possibility of being able to meet much of this need. Flexibility of alternatives in perception and action can only be provided in automated devices at a great penalty in weight and reliability. Man can better provide this flexibility for some time to come

A capability to deorbit a vehicle and exercise some control over the landing point is a fundamental necessity for large scale manned operations in space. A variety of methods for doing this are possible, ranging from MERCURY type capsules having no lift and low drag, to winged vehicles such as DYNA SOAR. It is the opinion of the Committee that research and development on re-entry vehicles should be directed primarily toward the achievement of high reliability, a high payload-to-total-weight ratio, and sufficient control over the landing point to make possible routine operations.

The mutually complementing capabilities of instruments and man, incorporated into large space systems of military and commercial value, will enormously increase their utility and reliability, whether men are used for continuous operation or only for periodic maintenance. As it becomes possible to man very large space stations, space technology itself will grow at a very rapid rate. These advances in technology will lead to military advantages to those who achieve them first.

A critical gap exists in the present U. S. manned space flight program, between MERCURY flights in 1961-62 and APOLLO flights leading to a manned space station 6 - 7 years later. During that time there is no planned effort to sustain a man in space for more than a few hours, or to use men to perform operations while in orbit.

A major question about manned space flight concerns the shielding requirements for protection against the Van Allen radiation belts and solar flares. Radiation measurements to date have not been primarily for the purpose of answering this question. Existing data indicates that the trapped radiation and cosmic rays probably do not require large amounts of shielding, provided that the passage through the belts is accomplished rapidly. Data on solar flares, however, are insufficient to allow realistic shielding estimates to be made, particularly outside the earth's magnetic field. Furthermore, considerably more detailed determinations of the character and intensity of the Van Allen radiation at various altitudes and latitudes are required to estimate shielding needs for manned space stations in high altitude orbits.

Manned exploration of the moon and planets will be among the greatest achievements of mankind, and will be viewed with interest and excitement by the entire world. The Air Force should be prepared to play its part in these achievements. If these achievements are spearheaded by the Soviets, our position as leaders of the free world will be seriously prejudiced.

It is the conviction of the Committee that extensive manned operations in space will ultimately be required for full utilization of the military opportunities offered by access to space. It is difficult to foresee a time at which human skills and flexibility can be completely, effectively, and efficiently replaced by mechanisms, and the full exploitation of possibilities for all types of manned space activities is a matter of extreme urgency bearing directly on our national security.

XII. SPACE INFORMATION SYSTEMS

The use of satellites to acquire, transmit, and dispense information should be regarded as the aspect of space operations presently most vital to the mission of the Air Force. Space operations offer very important contributions to both information-gathering and control aspects of the conduct of military intelligence and military operations through both long-lived and few-turn satellites.

Extension of our reconnaissance and surveillance capability are largely limited by our lack of large payload launch vehicles. These extensions of capability will involve launch vehicles ranging from the current booster combinations to those using boosters based on the F-1. Larger, more complex systems will tend to have shorter mean times to failure unless reliability is achieved by redundancy or by incorporating men in the system. Redundancy cannot be achieved by using many small satellites if correlatable information from multiple sensor systems is desired. Manned intelligence gathering systems require payloads of tens of thousands of pounds.

It is important to emphasize that concurrent developments in payload technology must also be pressed to realize these benefits. The development of better reusable memory systems will greatly enhance the usefulness of higher-resolution sensors. Maser devices may also provide extremely wide band data transmission links to relay information from the satellite to ground stations. Such communications of greatly increased capacity, may provide one alternative means of transmitting vital data from orbit in a timely, effective way. Other alternatives include use of sequential deorbiting of many small capsules to provide physical recovery with minimum time delay, and the use of man in the satellite as an information filter.

Use of satellites to acquire, transmit, and dispense information should be regarded as an aspect of space operations vital to the mission of the Air Force. The value of this capability is extremely high.

Our deterrent force may be required to absorb a first strike. This places a premium on maintaining maximum effective command and control of our forces. Communication satellites represent a most important means for meeting this need. They must be developed and protected to the best of our ability.

The current programs of meteorological observations from satellites (TIROS, NIMBUS) represent initial efforts in a field which has considerable benefits, civil as well as military. To realize these benefits, an extension of the capabilities of the present program is required.

With very accurate knowledge of the orbit of navigation satellites, precise local positions can be obtained anywhere on the globe by observation of these satellites. If the satellite orbit is well determined, the position of ground distress signals can be established and used in "rescue operations". All such operations have military as well as civil uses.

XIII. COUNTERSATELLITE SYSTEMS

Any satellite passing over this country whose function is not completely known could be a military threat. Inspection, and perhaps capture techniques, may be employed to determine whether a satellite of our own, which has ceased to function, has done so because of malfunction or enemy action.

The Soviet Union, as well as the United States, has compelling military reasons to employ satellites. The Soviets can now orbit large satellites, cause them to re-enter the atmosphere, and land at a place of their choosing. We must recognize the possibility that any such satellite could contain a large nuclear warhead.

The USSR has an urgent military need for continuously observing the disposition of the free world's sea, air, and missile forces. Their growing ballistic missile force makes imperative the acquisition of precise target information and the determination of target co-ordinates on a world-wide grid. There is every reason to believe that satellite reconnaissance has high priority in the Soviet space program and that their large payload "scientific" satellites circling the globe may now be securing military reconnaissance, surveillance, and geodetic data beyond their announced scientific objectives. Therefore, our present countersatellite programs must be strengthened.

Such capabilities will permit us to:

a. Alert and activate satellite inspection systems at the earliest possible time.

b. Distinguish between large satellites and small ones which may be serving different purposes and posing different threats.

c. Establish very early, very precise orbital data giving initial values for interceptors.

XIV. SPACE WEAPONS SYSTEMS

The dramatic possibility of offensive weapons in space must be recognized. There are major technical and economic questions concerning extended life space-based bombardment systems which cannot be answered by paper systems studies at the present time. De-orbiting accuracies, especially after extended orbit life, can be determined realistically only by experiment.

The use of nuclear explosions may be of extreme military importance since greater control can be exercised over the effects of nuclear explosions than is generally realized.

XV. CENTRAL CONCLUSIONS

A. Central Conclusions

1. The present lead of the USSR in basic capabilities such as size of payload in orbit, poses a major threat to the security of the United States. An increased space effort by the Department of Defense is urgently required.

2. The most pressing need is to develop the capability to reliably place larger payloads in space. The same urgency and magnitude of endeavor as was involved in the acceleration of the ICBM program in 1954 is required.

3. Satellites which acquire, transmit, and dispense information should be regarded as the aspect of space operations presently most vital to the mission of the Air Force. These satellites require improvements, all of which result in heavier payloads.

4. The military threat strongly suggests an immediate reappraisal of the need for developing countersatellite systems to protect the United States against hostile satellites.

5. The effective use of man in orbit is needed at the earliest achievable date. To meet military needs we shall have to learn to keep man in orbit safely and usefully.

B. Policy and Organization Recommendations

1. The funding and management of the development of reliable, fundamental space capabilities must be independent of, but closely integrated with, systems development, and also independent of scientific experiment and exploration. This provides an immediate point of focus for the newly defined Air Force space organization - the Air Force Systems Command.

2. The development of reliable basic capabilities in space should be undertaken by the Department of Defense because of its experience with operational demands for reliability and urgency.

3. The organization of the Air Force for space development must be changed to cope with and exploit the new dimension in national security implicit in space technology. The recent reorganization of Air Research and Development Command and Air Materiel Command is an initial step in this direction. However, this reorganization will not be fully effective unless there is a better defined organizational structure at the Headquarters Air Force, Department of Defense and National levels.

4. The traditional role of the military in support of scientific exploration should be as thoroughly recognized in space as on earth.

5. In preparation for both its military use of space and for its part in the exploration of space, the Air Force should accelerate and modify the training of its personnel.

6. The increasing importance of the biomedical and clinical problems of man in space calls for a reorganization and recasting of the Air Force effort on these problems.

7. The preparation of all Air Force public information plans and programs relating to space should be centralized in, and made the responsibility of, the Commander of the Air Force Systems Command.

C. The Need for Decision

The U. S. has a consistent record of under-reacting to the rate of Soviet technological and military progress - in nuclear and thermonuclear weapons, military aviation, IRBM's, ICBM's - and in space development. In addition, in the military space field, we have continued to under-imagine the possibilities of the future and are not yet organized to exploit them.

The Committee realizes that the sum of the recommendations in the report - covering policy, organization, and technology - represents a major departure from the dimension and scope of present and projected Air Force space activities. The emphasis on "Central Conclusions" does not reduce either the importance of or the need to implement the balance of the recommended actions contained in the body of the report. Only the most forceful measures will assure achievement of the target dates set forth. In the past, when faced with a similar threat, the nation has successfully responded to decision and leadership in overcoming the lead held by the opposition.

The Committee recommends that the imminence of the military space threat and proposed technical and organizational actions be brought to the attention of the highest levels of management within the Government at the earliest possible time. The change in scale required in the military space program is so vast that if it is to receive the necessary support from all levels of Government, it must have the understanding and endorsement of the appropriate Committees of the Congress and the President.

APPENDIX 1

LETTER FROM Lt GENERAL B. A. SCHRIEVER

HEADQUARTERS
AIR RESEARCH AND DEVELOPMENT COMMAND
United States Air Force
Andrews Air Force Base
Washington, D. C.

C
O
P
Y

11 October 1960

Mr. Trevor Gardner
Chairman and President
Hycon Manufacturing Company
1030 South Arroyo Parkway
Pasadena, California

Dear Trev:

The year 1960 has brought into sharp focus opportunities in space development which can materially strengthen our national security and perhaps insure our survival. These opportunities require clear definition, judicious selection and aggressive exploitation. In view of this fact and in order to properly discharge its national trust and responsibility the Air Force must establish as a matter or urgency a comprehensive and dynamic space development program.

To this end I propose to form a group of the nation's most eminent scientists and executives, similar to the von Neumann Committee of 1954, to advise and assist ARDC in carrying out its vital development responsibility in the critical decade ahead. Specifically, I would ask this group to:

a. Undertake a technical evaluation of existing and planned space systems and recommend a space development program for the USAF which would extend as far as practicable into the future and which would be designed both to provide the nation with a significant military space capability by mid-1965 and to advance the national prestige.

b. Review ARDC policies and procedures, including facilities, and advise as to their adequacy to achieve the desired objectives.

I can think of no one I would rather have act as chairman of such group than yourself. The key role you played in the formation of the von Neumann Committee and in the organization of the unique military and scientific management arrangement which made possible the achievement by the United States of an operational ICBM in record time is indeed a highlight of our nation's history. I therefore ask if you would be willing to assist the Air Force and the nation in such an assignment. In asking you to do this, I fully realize the heavy demands which are being made upon your time by other projects relating to the national security. If you agree to accept the chairmanship of the group we can meet to discuss the project in more detail. I would be hopeful of having a final report from the committee not later than January 15, 1961.

I have discussed the above plan with Dr. William O. Baker, Dr. Charles C. Lauritsen, and Dr. Jerome Wiesner. All have agreed to serve on the committee if you will act as chairman.

Sincerely yours,

/s/B. A. Schriever

B. A. SCHRIEVER
Lieutenant General, USAF
Commander

APPENDIX 2

COMMITTEE ORGANIZATION

The Air Force Space Study Committee was established by Lt. General B. A. Schriever, Commander, Air Research and Development Command, on 11 October 1960, under the chairmanship of Mr. Trevor Gardner. Its purpose was to advise and assist ARDC and the Air Force in carrying out their development responsibilities in space in the 1960 - 1970 time period. Its mission is described in Appendix 1.

The Committee held five meetings.

The first meeting was held in the Pentagon in Washington on 27-29 October 1960.

The second meeting also was held in the Pentagon on 27-29 November 1960.

The third meeting was held at the Air Force Ballistic Missile Division at Inglewood, California, on 18 and 19 January 1961.

The fourth meeting was held at the Air Force Ballistic Missile Division at Inglewood, California on 1 and 2 March 1961.

The fifth meeting was held at the Bell Telephone Laboratories in Murry Hill, N. J., and New York on 18 and 19 March 1961.

In addition to the formal meetings of the full Committee, there were many informal meetings of members to discuss specific problems.

It was clear after the first meeting that several studies would be required to provide the Committee with the information necessary for it to proceed with its assignment. Accordingly, a full-time technical group was established and housed at the Los Alamos Scientific Laboratory in New Mexico. This group conducted technical studies for the Committee.

It also was apparent that the management-organizational aspects of the national as well as the military effort were of primary importance to a sound space program. Consequently, a part of the Committee met with a selected group of other individuals having special experience and interest in this field to review the current space organization structure and to suggest a management arrangement to implement the Committee's recommendations on a timely and economic basis. This group met in the Pentagon on 30 January and 15 February 1961. Their report is contained in Section VII.

APPENDIX 3

COMMITTEE MEMBERS

AIR FORCE SPACE STUDY COMMITTEE

Mr. Trevor Gardner, CHAIRMAN	Chairman of the Board and President Hycon Manufacturing Company
Dr. William O. Baker	Vice President, Research Bell Telephone Laboratories
Dr. Harold Brown	Director Lawrence Radiation Laboratory University of California
Mr. William C. Foster	Vice President Olin Mathieson Chemical Corp.
Dr. Mark Kac	Professor of Mathematics Cornell University
Dr. Arthur R. Kantrowitz	Director AVCO-Everett Research Lab.
Dr. Charles C. Lauritsen	Professor of Physics California Institute of Technology
Dr. Conrad L. Longmire	Principal Research Scientist AVCO-Everett Research Lab.
Dr. W. Randolph Lovelace, II	Director, Lovelace Foundation
Dr. Frank T. McClure	Chairman, Research Center Applied Physics Laboratory Johns Hopkins University

Dr. Charles H. Townes	Vice President and Director of Research Institute for Defense Analysis
Dr. John W. Tukey	Professor of Mathematical Statistics Princeton University
Dr. Stanislaw M. Ulam	Research Advisor Los Alamos Scientific Laboratory
Col Vincent T. Ford	Headquarters, ARDC
LtCol David L. Carter EXECUTIVE	Deputy Director Advanced Plans and Analysis Air Force Ballistic Missile Division

AIR FORCE SPACE STUDY MANAGEMENT GROUP

Mr. Trevor Gardner, CHAIRMAN	Chairman of the Board and President Hycon Manufacturing Company
Dr. William O. Baker	Vice President, Research Bell Telephone Laboratories
Mr. John F. Floberg	General Counsel Firestone Tire and Rubber Company
Mr. William C. Foster	Vice President Olin Mathieson Chemical Corp.
Mr. James R. Kerr	President AVCO Corporation
BrigGen Charles A. Lindbergh	
Mr. Malcolm A. MacIntyre	Chairman of the Board and President Eastern Airlines, Inc.
Dr. Frank T. McClure	Chairman, Research Center Applied Physics Laboratory Johns Hopkins University
Mr. Frank Pace, Jr.	Chairman of the Board General Dynamics Corporation
Gen Nathan F. Twining	General, USAF (Ret)
Mr. Charles Tyroler, II	Senior Partner Counselors on National Problems
LtCol David L. Carter EXECUTIVE	Deputy Director Advanced Plans and Analysis Air Force Ballistic Missile Division

NOTE: The majority opinions of this group are set forth in Paragraphs 1 through 7 on pages 10, 11, and 12 of this report.

LOS ALAMOS STUDY GROUP

r. Theodore B. Taylor, CHAIRMAN	Senior Research Advisor General Atomic Division General Dynamics Corporation
Mr. Bruno W. Augenstein	Director, Advanced Planning Scientific Advisor, Satellite Projects Lockheed Missile & Space Division
Dr. George D. Bagley	Associate Director Electromagnetic System Division Space Technology Laboratories, Inc.
Mr. John C. Barnes	Chief, Advanced Systems Space and Information Systems Division North American Aviation Co.
. Keith A. Brueckner	Chairman, Department of Physics Institute of Technology and Engineering University of California
Dr. Robert W. Buchheim	Head, Astronautics Department The RAND Corporation
Dr. Thomas M. Burford	Staff Member, Mathematics Dept. Bell Telephone Laboratories
Dr. Robert W. Bussard	Staff Member Los Alamos Scientific Laboratory
Dr. Ralph S. Cooper	Staff Member Theoretical Division Los Alamos Scientific Laboratory

Dr. Robert H. Fox	Assistant Division Leader Nuclear Propulsion Division Lawrence Radiation Laboratory
Dr. Richard L. Garwin	Associate Director IBM Watson Laboratories
Dr. Amrom H. Katz	Reconnaissance Group Leader The RAND Corporation
Dr. Edward B. Rawson	Staff Physicist Scientific Engineering Institute
Mr. Addison M. Rothrock	Program Planning and Evaluation NASA Headquarters
Dr. Morris F. Scharff	Research Staff Member General Atomic Division General Dynamics Corporation
Mr. Robert C. Truax	Director, Advanced Developments Aerojet General Corporation
LtCol George W. S. Johnson, EXECUTIVE	Air Force Ballistic Missile Division

NOTE: This group provided invaluable technical assistance to the Air Force Space Study Committee. However, the conclusions of this report do not necessarily reflect their individual or collective opinions.